Getting to Early Physics

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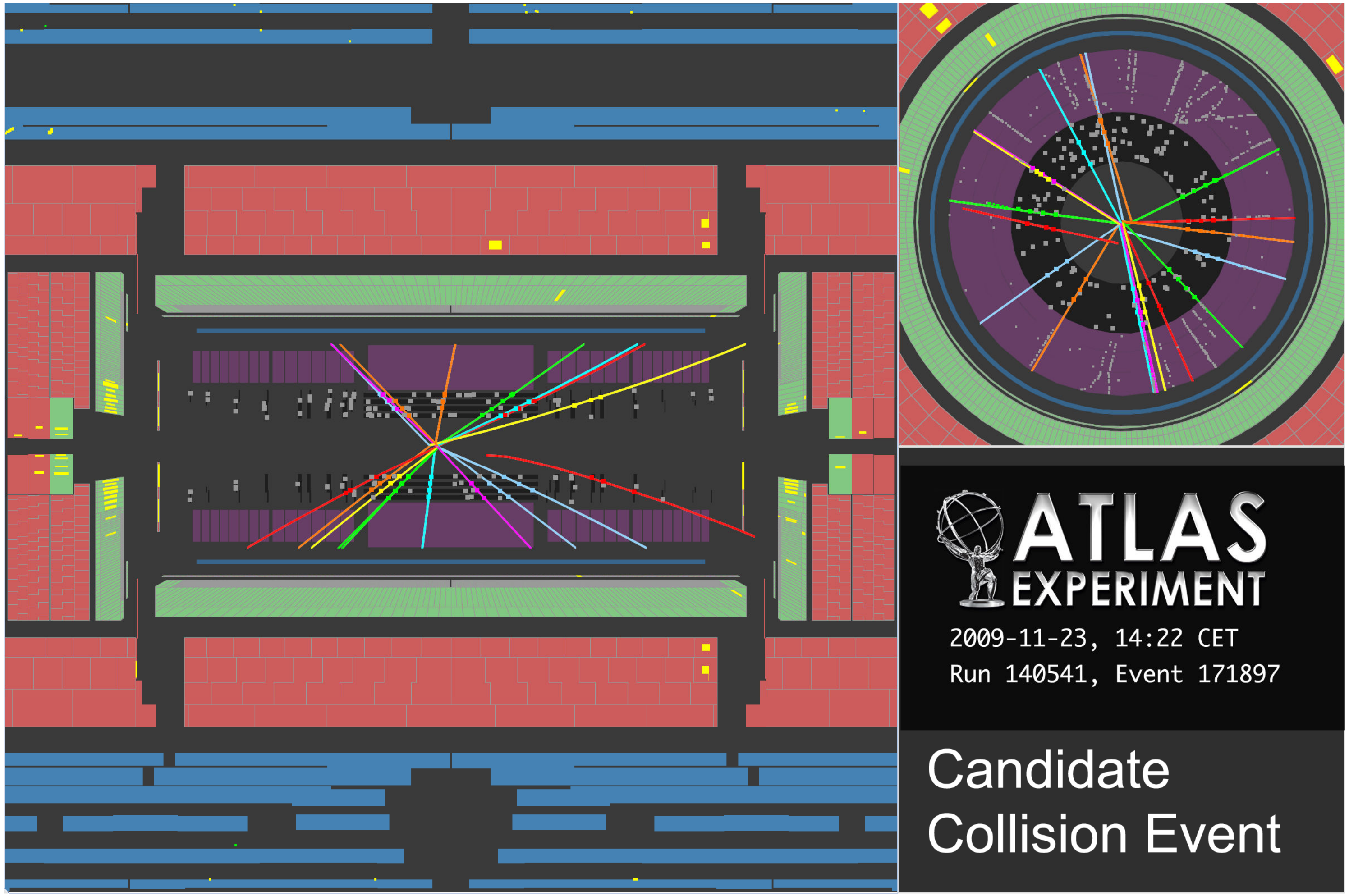
In Case You Were Living on Mars…

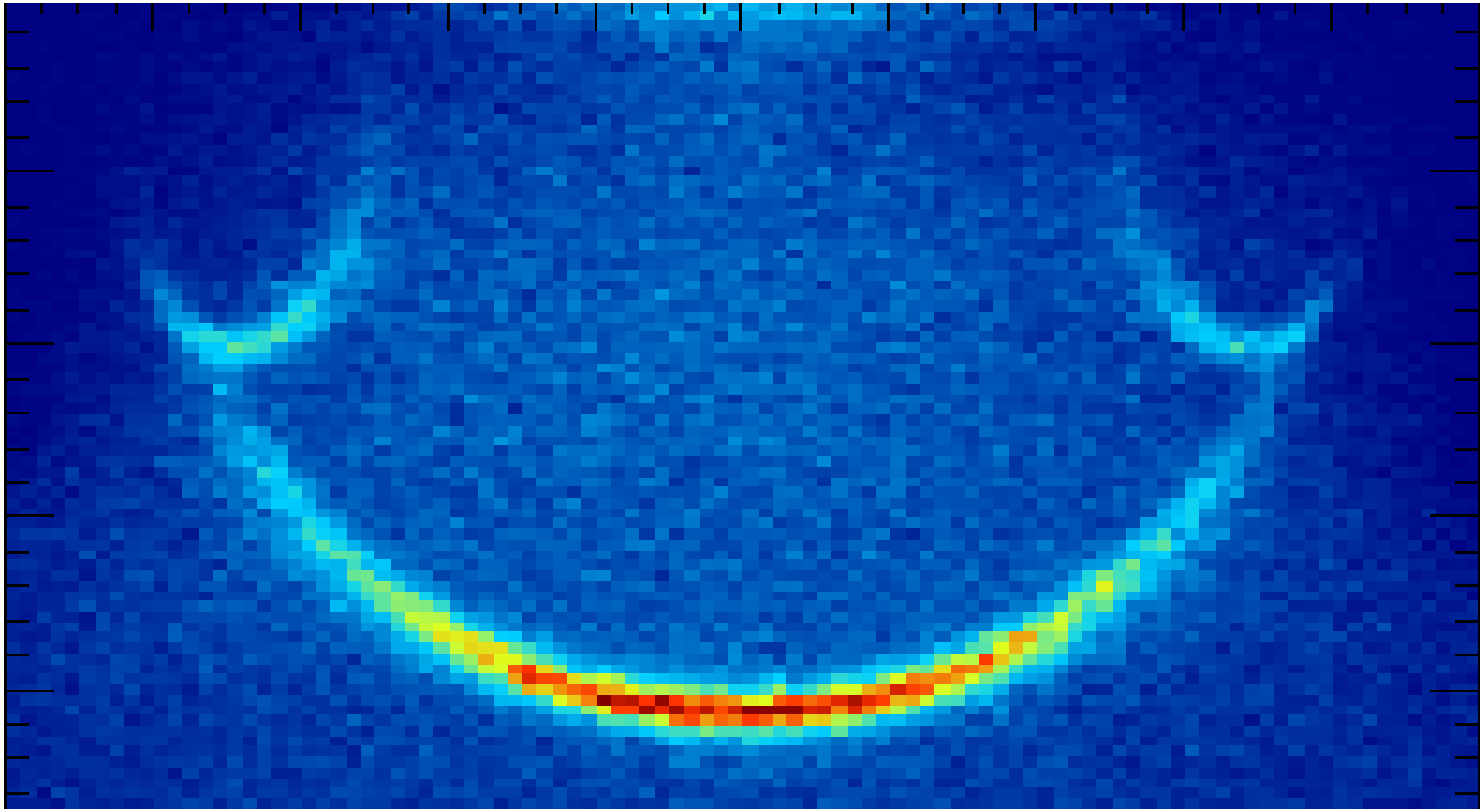
- The LHC Produced Collisions – and ATLAS recorded them!



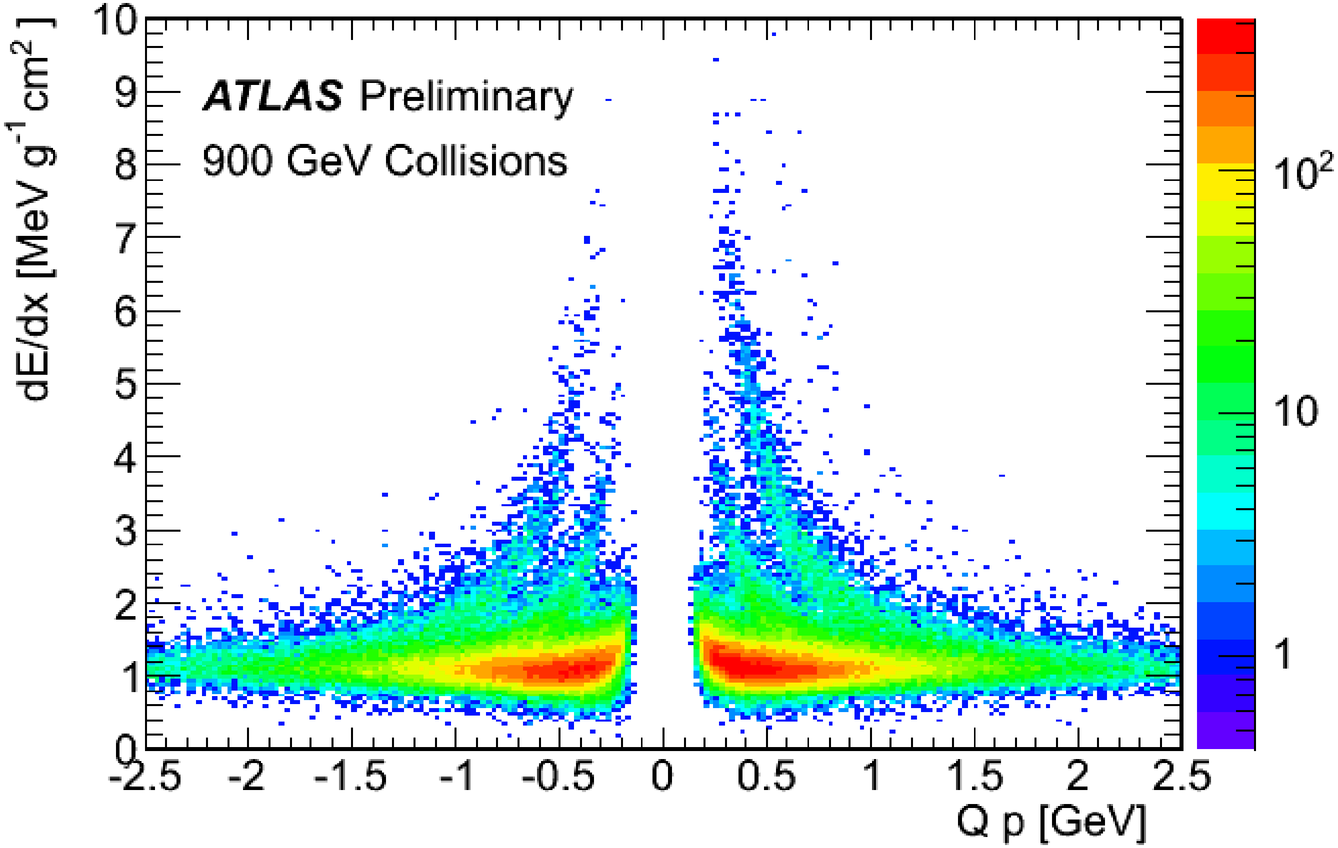
http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

One reaction…

A portrait of the Physics Coordinator after the data was analyzed



dE/dx in the pixels



There are 80,000,000 pixels and 160,000 tracks. So this plot is not just telling us how well the dE/dx works, it's telling us how well cross-calibrated the pixels are.

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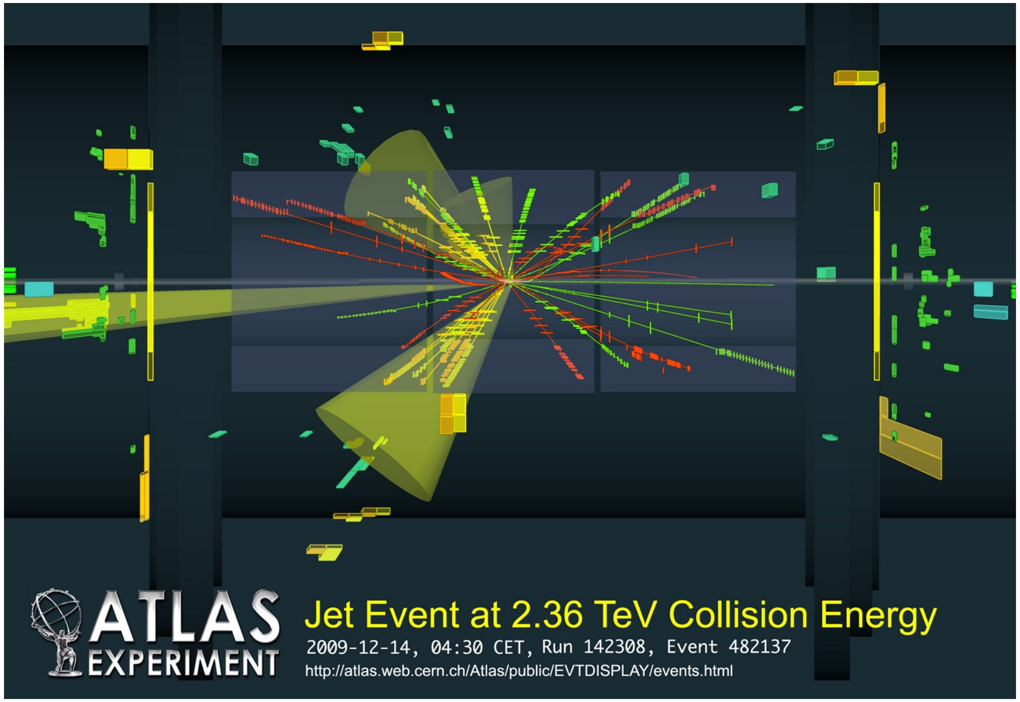
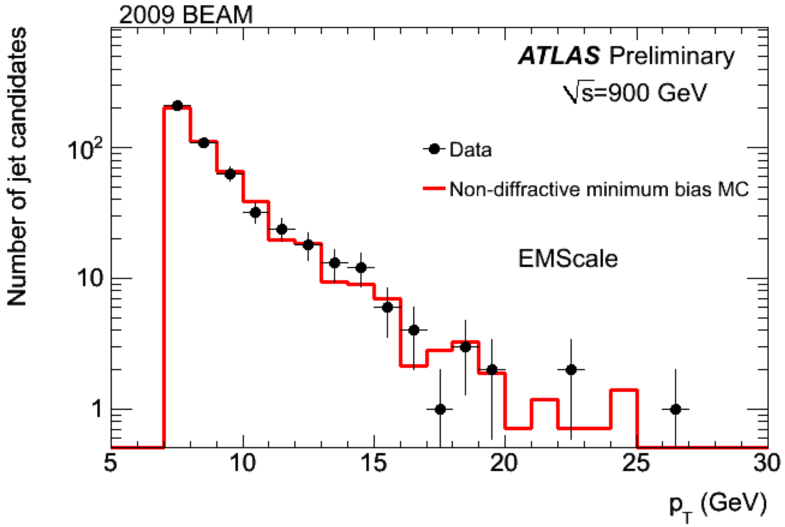
Jets



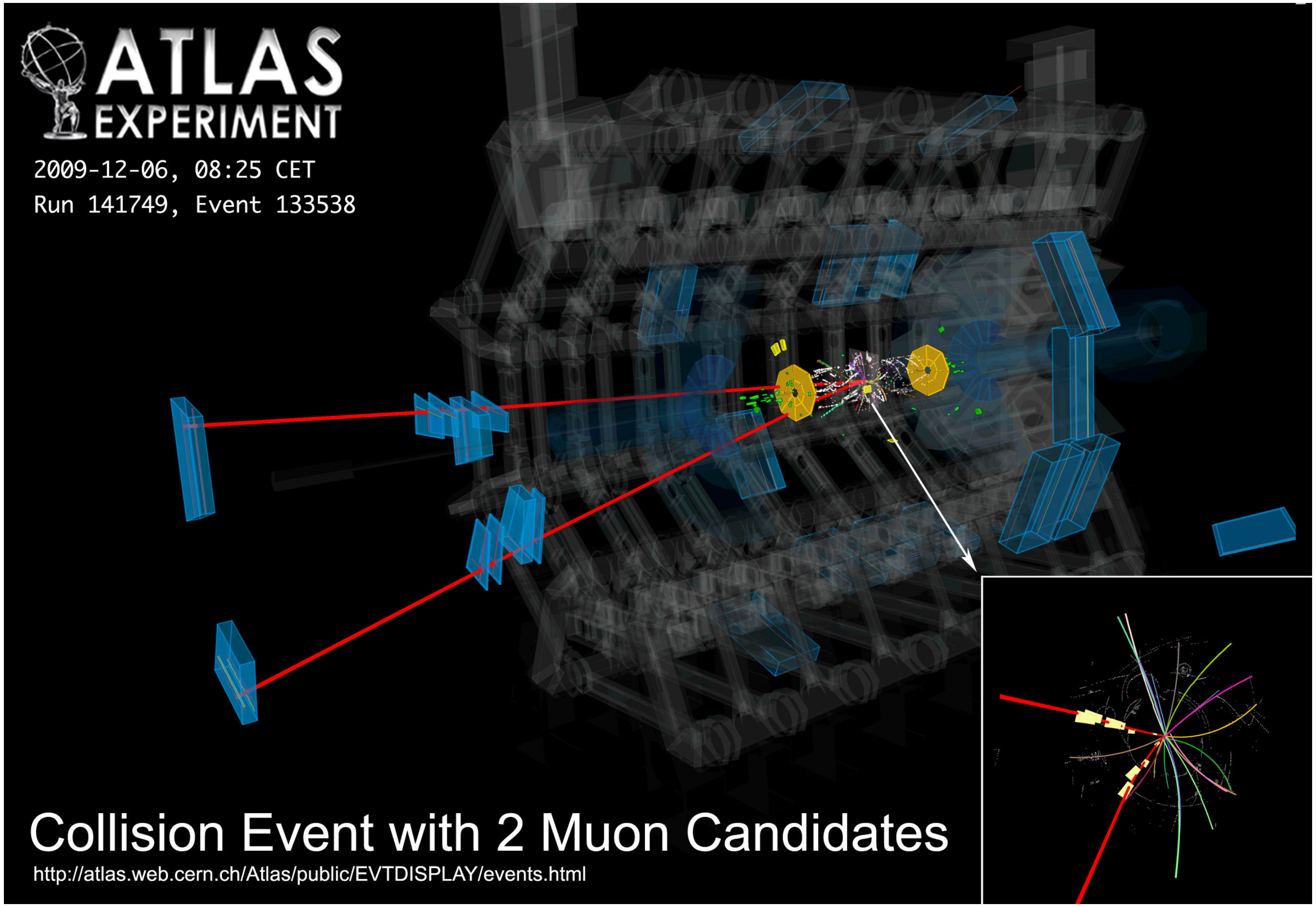
ATLAS sees jets. (The event on the left is our highest E_T jet, and was used for the ATLAS Christmas card)

ATLAS does not see many jets. 900 GeV is simply too low an energy to produce many observable jets.

Note that the jets we have are in a kinematic region of low and changing efficiency.

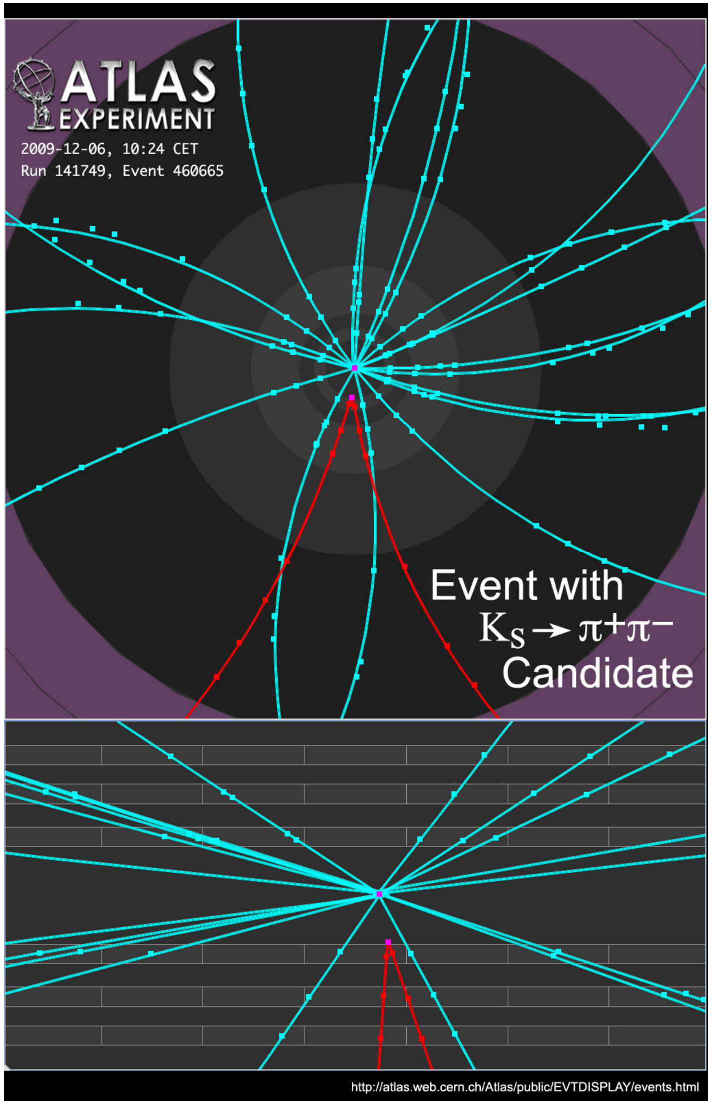


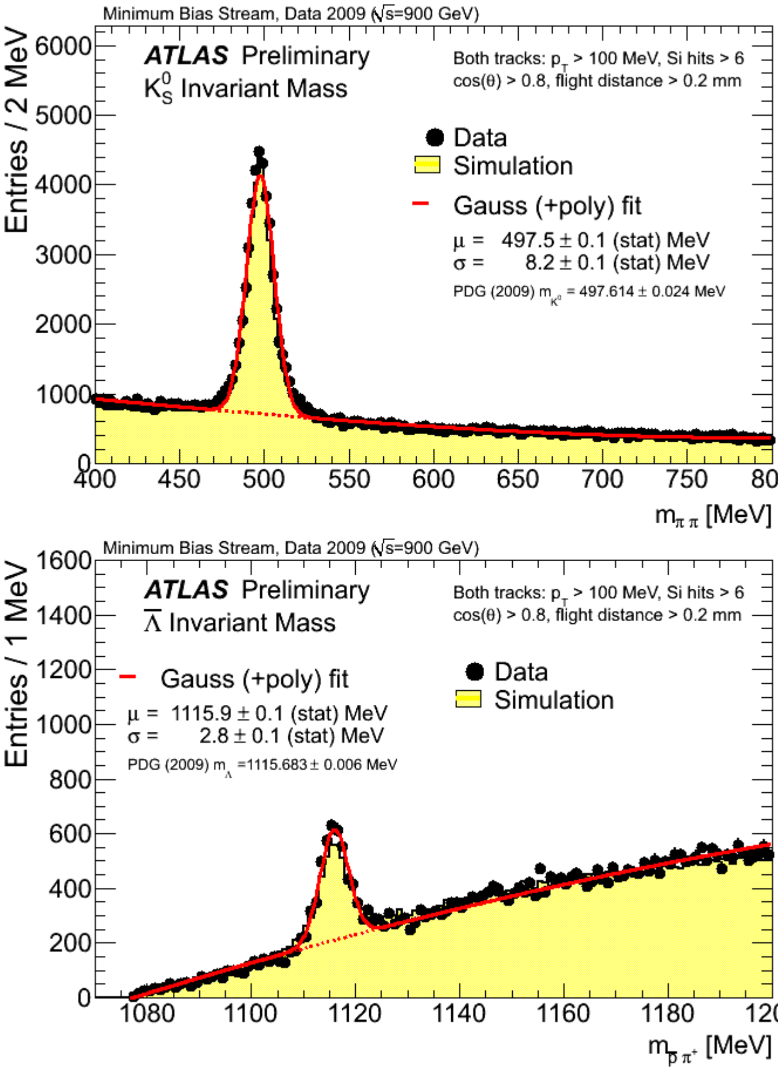
Muons



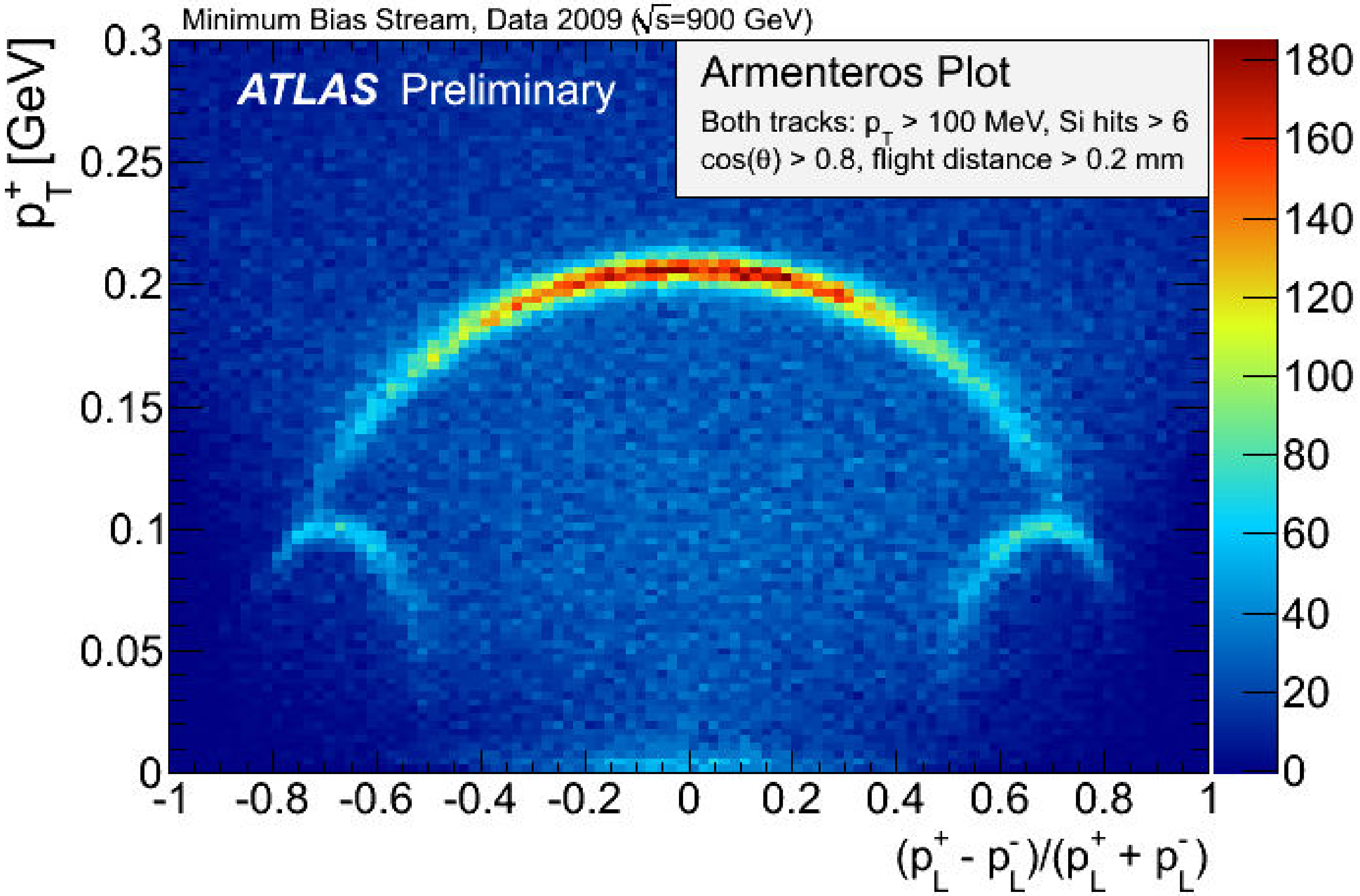
We have muons – but not many (dozens). In fact, we need to keep the toroids off in order to get a track in the muon spectrometer: otherwise they would be bent back into the calorimeters.

ATLAS and V0's

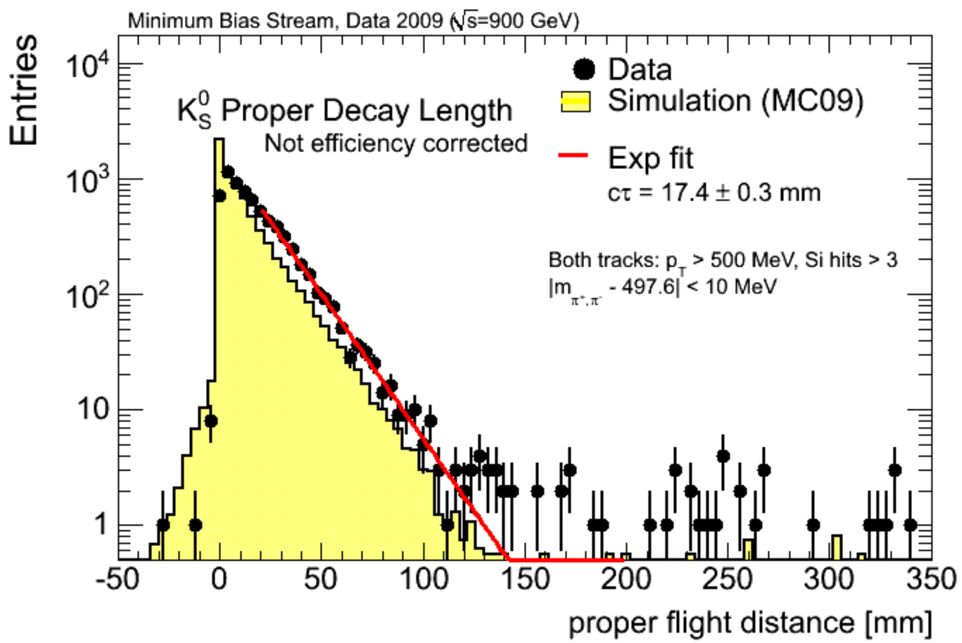




A Closer Look at the V0's



Still, More Work Needs to be Done



- The proper lifetime is biased about 30% low because we miss hits on pion daughter tracks from long-lived kaons.
- This distribution is very sensitive to issues of pattern recognition and hit inefficiencies – allows detailed checking between the data and our modeling of it (MC)

- Why does the Monte Carlo reproduce the data at short (proper) lifetime, but underpredict the data at long lifetime?

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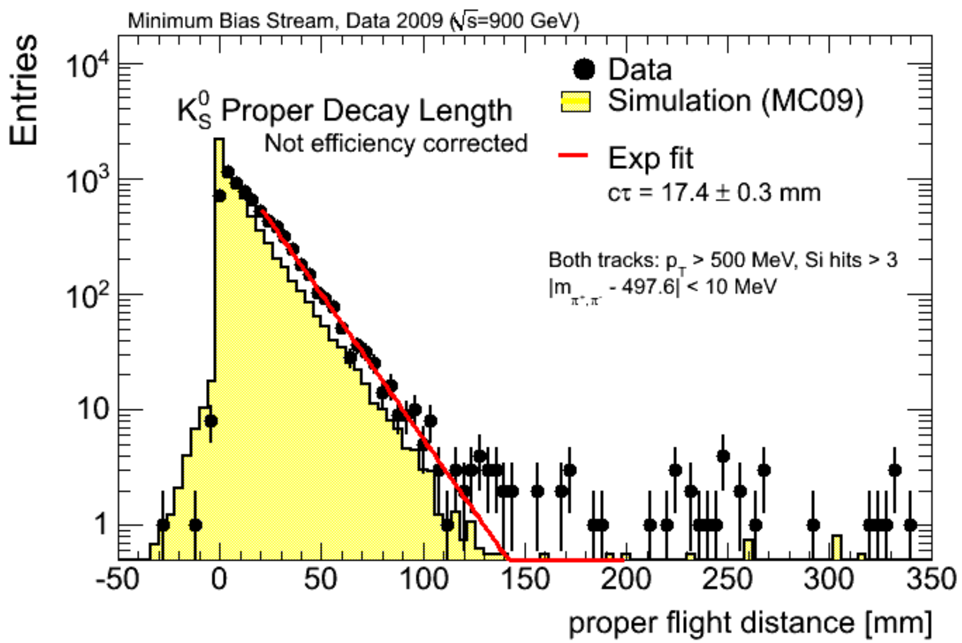

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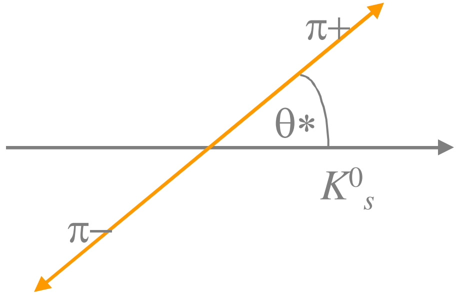
- Why does the Monte Carlo reproduce the data at short (proper) lifetime, but underpredict the data at long lifetime?

If your response is “did you make such and such a plot”, the answer is “no” – I don’t get to make any plots, unfortunately. I’m giving this to recruit people to make these plots!

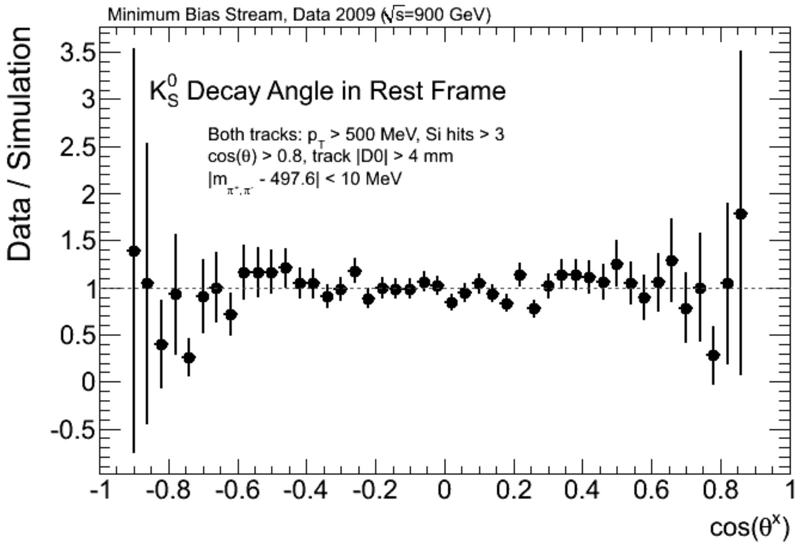
Plots by Till Eifert

K-shorts: Part II

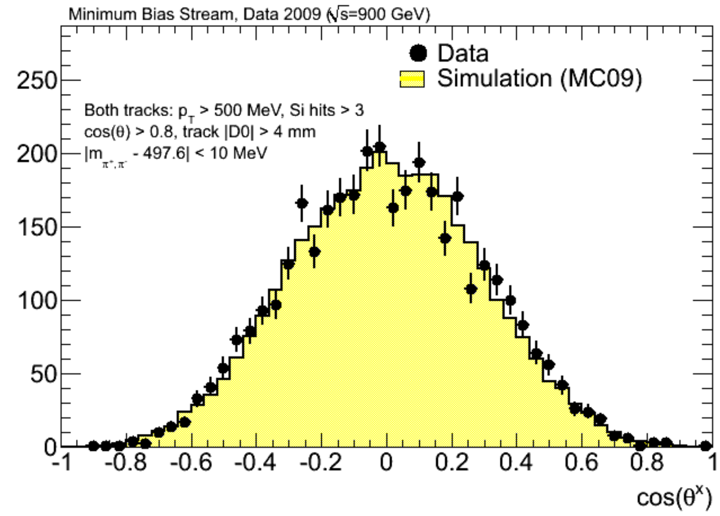
- Because the K-short is a (pseudo)-scalar, it's helicity distribution must be flat in $\cos(\theta^*)$.



- Large $|\cos(\theta^*)|$ means you have one stiff and one soft track – this probes efficiency for low momentum particles



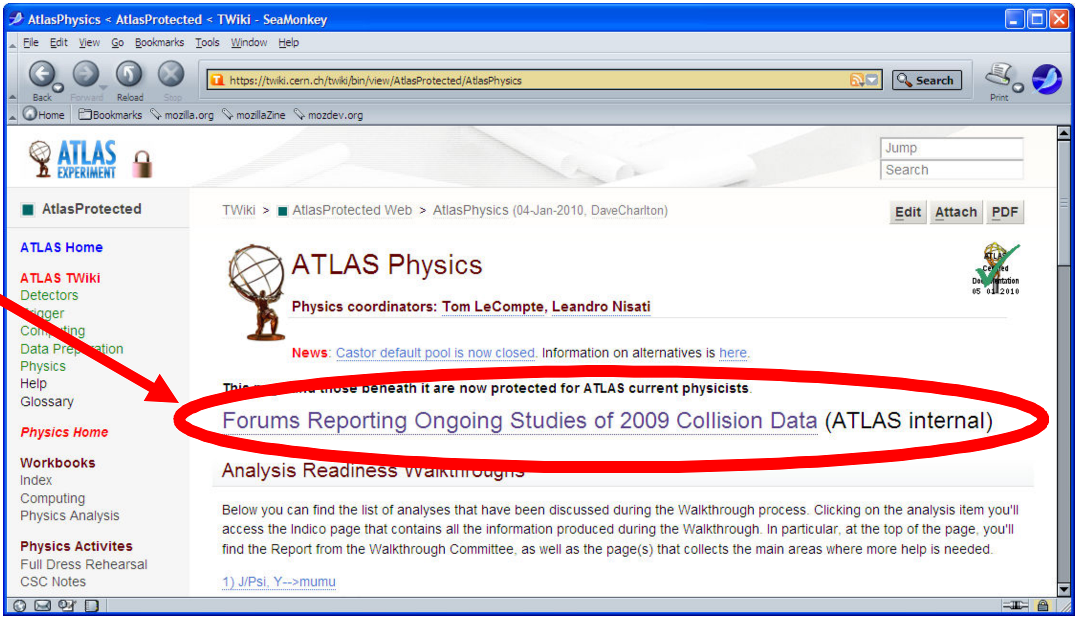
- This distribution is driven by the efficiency and acceptance – not by the physics of K-short decays



- **Conclusions:**
- Already our Monte Carlo does a very good job of modeling the acceptance and efficiencies – no discrepancies are seen.
- We need a lot more data to probe the efficiency at the level we would like for track-based physics measurements.

Getting Involved

- Every Combined Performance Working Group has set up an “Early Plots & Discussion” page
  - Some are Indico
  - Many are Sharepoint (Hypernews replacement)
    - A very nice feature is that this supports RSS feeds

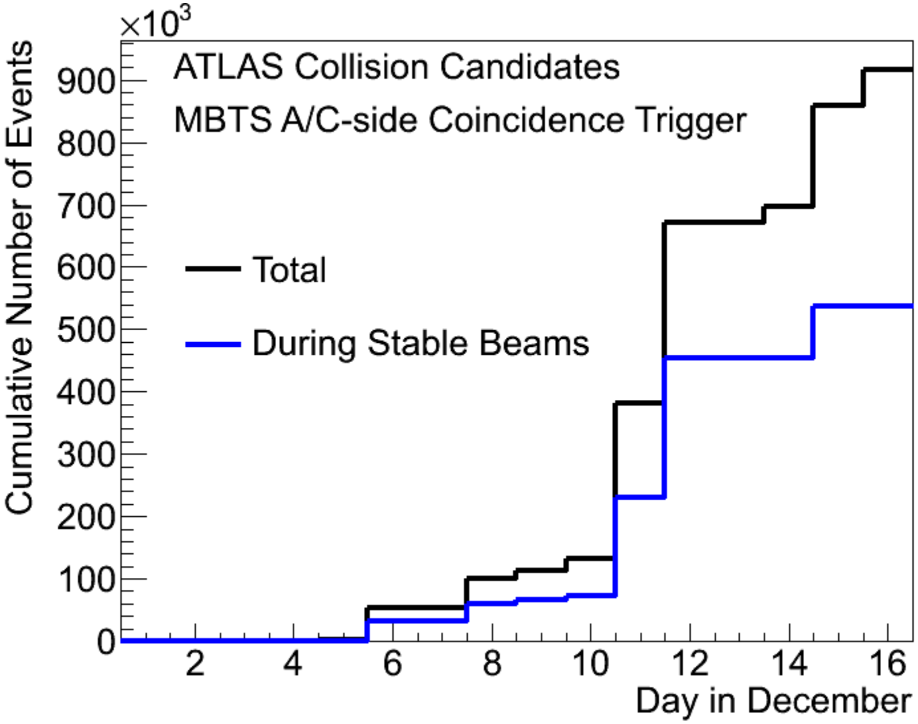


- These pages are very active – both inside CERN and across Europe
  - For reasons I do not understand, there has been relatively little involvement in the Americas and Asia/Pacific regions.
  - Most American involvement is from people resident at CERN

- I would like to see us take advantage of our round planet and have these activities continue when it’s night in Europe.

Extrapolating from LHC Experience

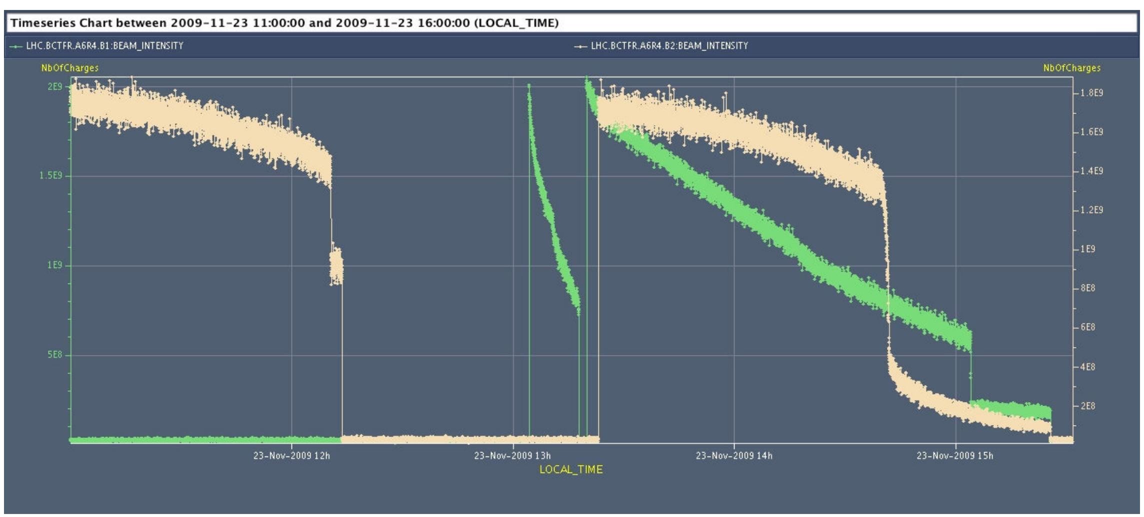
- The posted LHC plan for 900 GeV was three days of operation, delivering 1000 μb^{-1}, or about 40 million events.
- Instead, we got 23 days of operations, ~20 μb^{-1} of collisions, 12 μb^{-1} with the stable beam flag set.
  - Reminder: w/o stable beams, the SCT and often the pixels are "off".



- Is the correct conclusion that the LHC startup is "troubled" and that we should have low expectations for the rest of 2010?
- In the next few slides, I will argue that it is not.

More Details about 2009 Run

- Key goal – "don't break the LHC"
- Operational version of this goal – "don't quench the magnets unnecessarily"
- Effect of this goal – "the number of protons (and therefore luminosity) in the LHC is set by the loss rate"
- Beam 2 had a terrible lifetime
  - It was shedding protons
  - Which limited the number of protons they were willing to inject
    - Remember, "lost" protons end up somewhere.



Plot from CMS

Why 2010 will not be like 2009

- The Beam 2 lifetime problem is solved
  - It goes away at 1180 GeV per beam
  - Better, it's understood: they were operating too near the 2:7 resonance.
- There's more to the story than delivered luminosity – the LHC met some major milestones
  - Commissioned the ramp to 1180 GeV (maximum safe energy in 2009)
    - On the third try!
  - Began to squeeze the beam
    - Reached β^* of 7m (vs. 11m unsqueezed)
- Machine up-time was 65%
  - Reminder: the plan was for 30%, and some called this "recklessly optimistic"
  - The larger the up-time fraction, the **faster** the machine can be commissioned
    - Delivered luminosity is a superlinear function of up-time

Conclusions for 2010

- Inferring that 2010 will be a low-luminosity year based on what was delivered in 2009 is not justified

- I won't say that there won't be problems in 2010
  - There probably will
  - Some may be serious – it's too soon to tell.

- It would be a mistake to "plan to fail"
  - We need to be prepared for delivery of many hundreds of pb^{-1}: possibly more than they have predicted so far.
  - We need to spend the time before mid-February getting as much as we can out of the 2009 data, so we're ready to go as soon as the machine is.

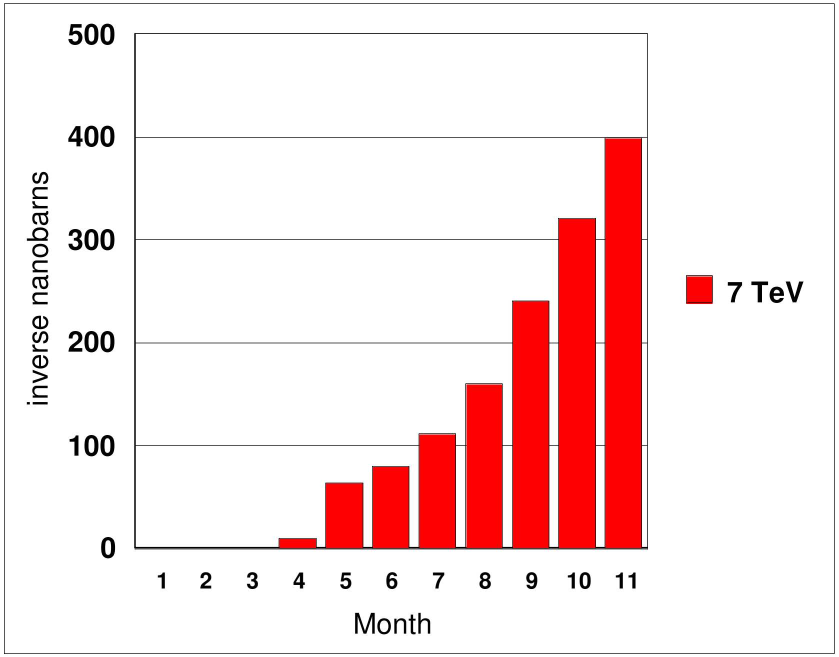
100's of pb^{-1}?

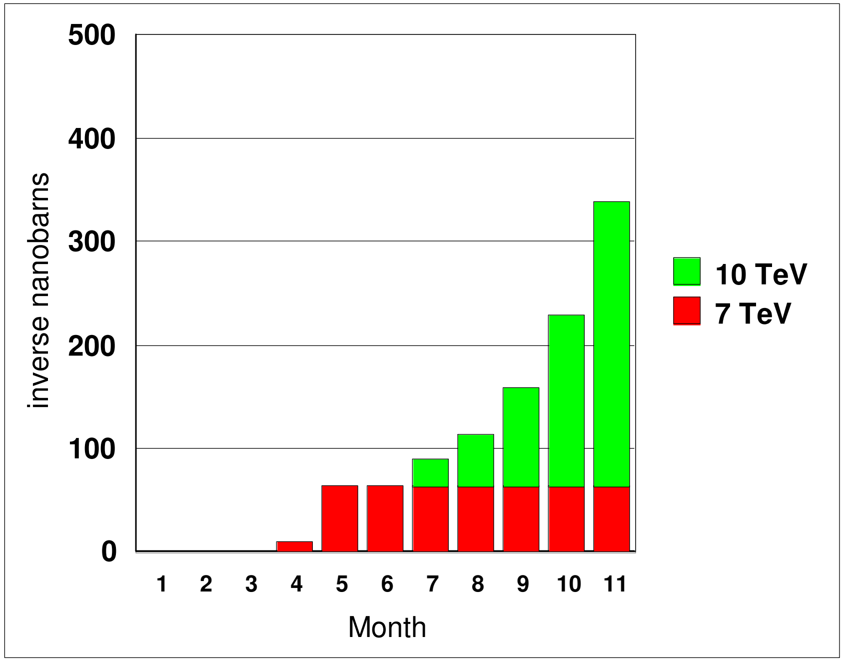
- Here are some slides I showed at the last jamboree
- They were based on Mike Lamont's presentation to the EB on expected LHC performance (assuming 30% up-time).
- You will see that 500 pb^{-1} was in the cards back then
  - If they can keep this 65% up-time, this looks quite realistic

Run Models

Shown last jamboree

- These are run *models*, not run *plans*.
  - The run plan will evolve as we gain experience
- Taking these at face value, we can ask what we will expect
  - 400 pb^{-1} for a 7 TeV only run, and 65 pb^{-1} + 275 pb^{-1} for a 7+10 TeV run





More on Models

Shown last jamboree

- It's difficult to compare different center-of-mass energies
  - Different physics processes have different scalings
  - I will use an average of top quarks, Z primes, and SUSY here, and try and equate this to 10 TeV equivalent luminosity
    - Reminder: 100-200 pb^{-1} at 10 TeV is where we start to have sensitivity substantially beyond present limits

- A few models:
  - 7 TeV only: 115 pb^{-1} equivalent
  - 7 TeV, then 10 TeV: 300 pb^{-1} equivalent
  - Run 7 TeV until we get 100 pb^{-1}, and then run 10 TeV: 130 pb^{-1} equivalent
  - 7 TeV, then 8.5 TeV: 160 pb^{-1} equivalent
  - Commission 15% slower: 115 pb^{-1} equivalent
  - **Commission 15% faster: 500 pb^{-1} equivalent**

Variations are substantial, but not orders of magnitude

Conclusions

- It's much better to be on a running experiment in the middle of a shutdown than an experiment waiting for beam.

- The 900/2360 GeV data allowed us to get a head start on detector commissioning
  - The trigger is in cutting mode
  - Much work was done on the Inner Detector (but it is far from complete!)
  - Commissioning the calorimeters and muon spectrometer is less advanced
    - Not many events provide signals that deep in ATLAS

- We need to plan for a lot of data arriving early in 2010, which means…

- We need to be commissioning ATLAS now.

Backup

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A 7 TeV Run Model

Plugging in the numbers – 3.5 TeV

Month	OP scenario	Max number bunch	Protons per bunch	Min beta*	Peak Lumi	Integrated	% nominal	events/X
1	Beam commissioning							
2	Pilot physics combined with commissioning	43	3×10^{10}	4	8.6×10^{29}	~200 nb^{-1}		
3		43	5×10^{10}	4	2.4×10^{30}	~1 pb^{-1}		
4		156	5×10^{10}	2	1.7×10^{31}	~9 pb^{-1}	2.5	
5a	No crossing angle	156	7×10^{10}	2	3.4×10^{31}	~18 pb^{-1}	3.4	
5b	No crossing angle – pushing bunch intensity	156	1×10^{11}	2	6.9×10^{31}	~36 pb^{-1}	4.8	1.6
6	partial 50 ns – nominal crossing angle	144	7×10^{10}	2-3	3.1×10^{31}	~16 pb^{-1}	3.1	0.8
7		288	7×10^{10}	2-3	8.6×10^{31}	~32 pb^{-1}	6.2	
8		432	7×10^{10}	2-3	9.2×10^{31}	~48 pb^{-1}	9.4	
9		432	9×10^{10}	2-3	1.5×10^{32}	~80 pb^{-1}	12	
10		432	9×10^{10}	2-3	1.5×10^{32}	~80 pb^{-1}	12	
11		432	9×10^{10}	2-3	1.5×10^{32}	~80 pb^{-1}	12	

Mike Lamont, ATLAS Open EB 27 Aug

U.S. DEPARTMENT OF ENERGY

A 7 & 10 TeV Run Model

Plugging in the numbers with a step in energy

Month	OP scenario	Max number bunch	Protons per bunch	Min beta*	Peak Lumi	Integrated	% nominal	events/X
1	Beam commissioning							
2	Pilot physics combined with commissioning	43	3×10^{10}	4	8.6×10^{29}	~200 nb^{-1}		
3		43	5×10^{10}	4	2.4×10^{30}	~1 pb^{-1}		
4		156	5×10^{10}	2	1.7×10^{31}	~9 pb^{-1}	2.5	
5a	No crossing angle	156	7×10^{10}	2	3.4×10^{31}	~18 pb^{-1}	3.4	0.8
5b	No crossing angle – pushing bunch intensity	156	1×10^{11}	2	6.9×10^{31}	~36 pb^{-1}	4.8	1.6
6	Shift to higher energy: approx 4 weeks	Would aim for physics without crossing angle in the first instance with a gentle ramp back up in intensity						
7	4 – 5 TeV (5 TeV luminosity numbers quoted)	156	7×10^{10}	2	4.9×10^{31}	~26 pb^{-1}	3.4	
8	50 ns – nominal crossing angle	144	7×10^{10}	2	4.4×10^{31}	~23 pb^{-1}	3.1	1.1
9	50 ns	288	7×10^{10}	2	8.8×10^{31}	~46 pb^{-1}	6.2	
10	50 ns	432	7×10^{10}	2	1.3×10^{32}	~69 pb^{-1}	9.4	
11	50 ns	432	9×10^{10}	2	2.1×10^{32}	~110 pb^{-1}	12	

Mike Lamont, ATLAS Open EB 27 Aug